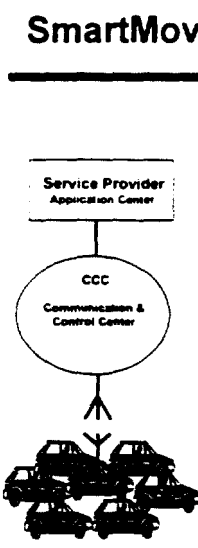
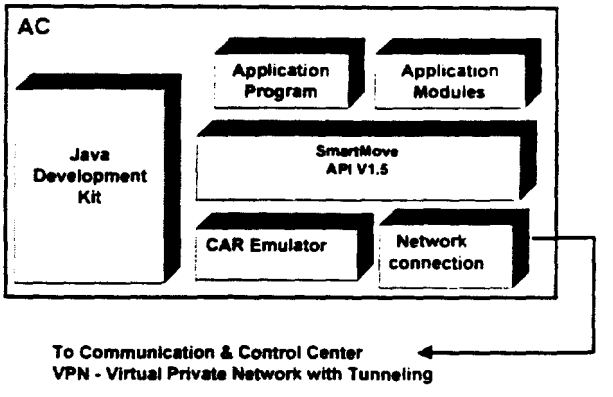
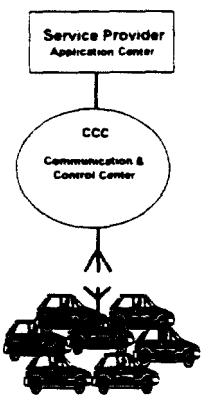
SmartMove Development Kit

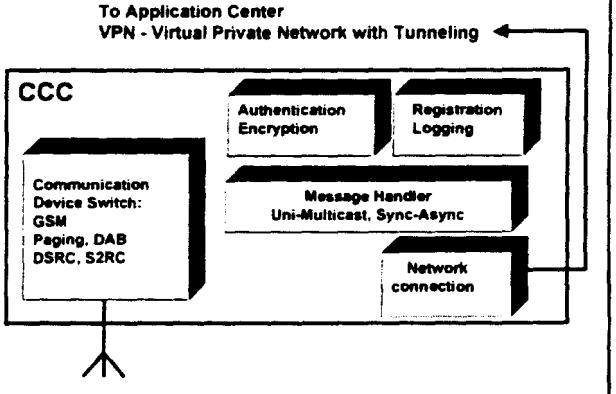




9

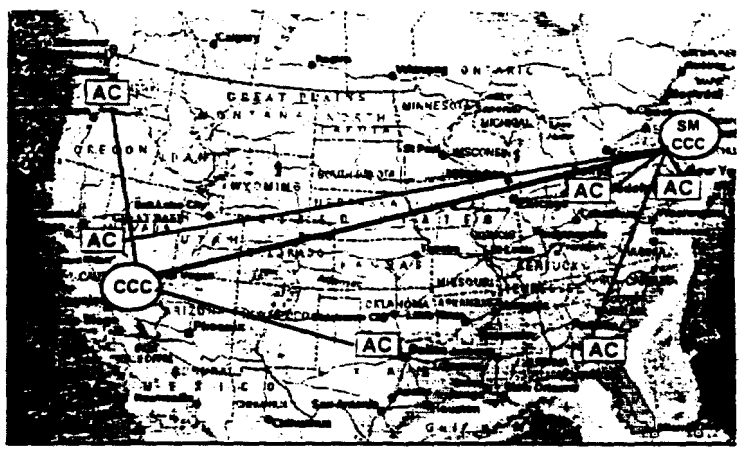
The Communication & Control Center





10

A typical AC - CCC Topology



11

Why is SmartMove here today ?

To show and to share our expertise on DSRC

And

To give input as a telematics solution provider

12

SmartMove's DSRC expertise

- ✓ 15 years of experience in the field of **chip design and methodologies** together with IMEC
- ✓ Experience in :
  - **short range communications**
  - **multipath** environments based on practical results and simulations
  - **spread spectrum** techniques (DSSS - CDMA)
  - **Orthogonal Frequency Division Multiplexing** (OFDM)
  - **microwave techniques** at ***2.4 GHz and 5.8 GHz***
- ✓ **Custom Chip** based on OFDM at IMEC (Rate > 50 Mbit/s - goal >155MBit/s)

Why an OFDM based solution ?

- ✓ **High speed** (>24MBit/s (QPSK))
- ✓ **Short range** (1 - 1000m)
- ✓ Architecture optimized for **mobile communication**
  - ✓ Reliable in harsh **mobile environments**
  - ✓ Resistant to **multipath** fading
  - ✓ Resistant to **frequency selective** fading
  - ✓ Less complex channel equalization
  - ✓ Resistance to **burst interference**
  - ✓ Low **latency; for real time applications (driver safety enhancement, and adaptive cruise control, etc.)**

Research Partner - Caltrans

- ✓ **California Department of Transportation**
- ✓ Established the **Testbed Center for Interoperability** (TCFI) at the University of Santa Barbara (1992)
- ✓ Caltrans-TCFI is a **pioneer** in the field of interoperability and DSRC applied research
  - o Initiated first ITS (IVHS) Communications research and DSRC standards (1991)
  - o DSRC Channel **characterization** model development, and testing
  - o Address both lower layers (Physical/MAC) as well as upper layer alternatives
  - o Demonstrate ITS standards Interoperability & System integration solutions
- ✓ The testbed provides **facilities for applied research** in the following areas
  - o Distributed systems (Application layer)
  - o Transportation information and control
  - o ITS Standards and interoperability and integration
- ✓ The Testbed Center For Interoperability (TCFI) as a vendor neutral DSRC Testing facility

Caltrans and SmartMove

- ✓ **To develop a common wideband DSRC standard that:**
  - o Achieve Interoperability
  - o Provide a validated Reference design and test data
- ✓ A standard for **users** ⇒ Caltrans
  - o Specifications Development of next generation DSRC (one wideband interoperable standard)
  - o Validate, verify and test alternative implementations in a realistic environment
  - o Development of an interoperable ITS infrastructure (Interoperability by Design)
  - o Representative for the public agency sectors in California
- ✓ Based on wideband wireless **technology** ⇒ SmartMove
  - o Orthogonal Frequency Division Multiple Access (OFDM)
  - o Custom chip
  - o Proven technology
  - o High speed communication

Envisaged market

- ✓ **Public safety**
  - o Large scale Emergency response & Disaster recovery Coordination
  - o Work zone safety warning
  - o Intersection collision avoidance
  - o Structure integrity Inspection & Monitoring
  - o Road characteristic warning
- ✓ **Information & services**
  - o Probe data collection
  - o In vehicle Signage
  - o In Vehicle multimedia
  - o Electronic fee collection
  - o Parking information
  - o Roadmap update
  - o drive through shopping

OFDM is becoming mainstream technology

- ✓ Used in wireless LAN (802.11a)
- ✓ Used in Digital Audio Broadcasting (DAB)
- ✓ Used in Digital Video Broadcasting (DVB-T)

A new standard ?

✓ **There is a need for !**

- o **High data rates** for multimedia applications and large blocks of data
- o Reliable for **safety applications** in a harsh environment
- o Ready for **future applications**

We are evolving to a society based on information (a lot...)

SMARTMOVE®
VEHICLE COMMUNICATION

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Applications of DSRC to Advanced Vehicle Control and Safety Systems (AVCSS)

Steven E. Shladover, Sc.D.
PATH Deputy Director
Institute of Transportation Studies
University of California, Berkeley

PATH

1

Outline

- Applications for vehicle-roadside communication
- Applications for vehicle-vehicle communication
- Key issues for these applications
- (Postscript -- State DOT Concerns)

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2

Vehicle-Roadside Communications

- Intersection and railroad crossing collision warnings
  - locations and speeds of approaching vehicles
- Work zone warnings
- Emergency vehicle signal priority
- In-vehicle signing (IVSAWS) and information needed by in-vehicle warning and control systems
  - local speed limits
  - curves, grades and other geometrics
  - weather and road surface conditions

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Vehicle-Roadside Communications (continued)

- Merge junction (on-ramp) coordination
- "Base stations" for reconfiguring mobile LANs
- "Relay stations" for vehicles sensing the driving environment ("Cooperative driving" in PROMETHEUS)
  - obstacles
  - vehicle failures
  - traffic jams
  - poor traction, etc.
- Safety "check in" and "check out" stations for AHS

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Vehicle-Vehicle Communications

- Cooperative adaptive cruise control (CACC)
  - speed, acceleration, braking, condition of preceding vehicle
- More general cooperative driving
  - relaying obstacle warnings
  - traffic and road surface conditions
  - failure/emergency flags
  - coordinated maneuvering
  - warnings of braking and lane changing
- Truck convoying (Chauffeur Project)
- Bus platooning (for Bus Rapid Transit)

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5

Key Issues for These Applications

- Message priority based on safety/urgency
- Reliability/robustness of messaging
  - safety-critical applications
  - need more overhead to ensure safety
  - protocols to provide handshaking/verification
- Provide now for future growth of needs
- First-generation technologies available
  - IEEE 802.11 MAC/DLC protocols
  - Bluetooth™ protocols

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6

Key Issues (continued)

- Early standardization of DSRC could accelerate AVCSS market development by creating a more "sensor friendly" roadway environment
  - identifying roadway clutter and geometry changes
  - identifying other vehicles and their behaviors explicitly
  - greatly simplifying sensor requirements
- Even more advanced vehicle control applications can use moderate data rates:
  - 20 ms updates of location, speed, acceleration, fault flags use about 4 kbps net (without overheads)

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Key Issues (concluded)

- National leadership (USDOT and ITS America) is needed to establish a solid foundation on which industry can build new products

PATH

PRELIMINARY RESULTS OF THE STAKEHOLDERS' WORKSHOP ON DEDICATED SHORT-RANGE COMMUNICATIONS AT 5.9 GHz.

5.9 GHZ is dedicated to ITS applications

1. A primary attraction of the 5.9 GHz band for ITS applications is that it has been specifically set aside for these ITS uses. Other bands, especially where licensing is not required (e.g., 902-928 MHz), are vulnerable to crowding and interference. Lack of contention is especially important for safety-critical activities where reliability and speed are crucial. In addition, liability risks may be lower using of a band (like 5.9 GHz) where users have co-primary status and must be licensed.

DSRC aimed at applications needing high-reliability, real-time communications with moving vehicle. Without DSRC, some safety applications may not get deployed

2. Dedicated Short-Range Communication (DSRC) is particularly appropriate for applications whose requirements include high-reliability real-time data communications with a rapidly moving vehicle. High-reliability in this context includes the high likelihood of channel availability when needed. Commercial two-way radio, satellite communications, and cellular telephony do not meet the need for both high-reliability and real-time service and, in some cases, do not provide needed coverage. Applications include: toll collection (more generally road pricing), transparent commercial vehicle border crossing, traffic signal preemption by emergency and transit vehicles (green wave), in-vehicle warning systems for highway-rail intersections and highway work zones, etc. In the absence of a well-established DSRC base, some of these safety applications could be difficult or impractical to implement.

DSRC could be suitable for other applications as well, given a sizable installed based of DSRC

3. There are a variety of other applications, whose vehicle-infrastructure (VI) communications requirements are less demanding than those above. DSRC will work for these applications, too, but so will other VI communications technologies. These applications include a variety of fee payment applications (at quick service restaurant drive-throughs, parking lots, pay-at-the-pump gas stations, etc.) DSRC would probably not be the technology of first choice for these applications, but if vehicles were already equipped for DSRC, then using DSRC would potentially be more attractive than adding another RF device in the vehicle. Some applications have broader bandwidth or higher data throughput requirements than are currently envisioned for DSRC. These include multimedia applications (e.g., downloading a movie to a backseat entertainment system) and internet connection. Some, but probably not all, of these applications could be handled by an enhanced version of DSRC.

Only a clear market can justify the large technology investment needed for DSRC at 5.9GHz

4. Making DSRC available in the 5.9 GHz band will require a very large technology investment by prospective vendors. The vendors are reluctant to make such an investment unless there is a clear market for the resulting products. The case for such an investment depends on (a) the selection of DSRC at 5.9 GHz for a variety of applications beyond toll collection and CVO crossings, or (b) the decision to incorporate DSRC/5.9 transponders as standard equipment in new vehicles.

   In turn, the market for DSRC depends, among other things, on the deployment of public and private infrastructure that will make use of DSRC at 5.9 GHz for fee collection, information delivery, etc.

Other communication technologies are almost ready for deployment

5. However, other technologies for VI communications are coming rapidly to market which can meet the requirements of applications that do not involve communicating with vehicles traveling at high speed. If DSRC at 5.9 GHz is not ready for deployment very soon, then these less demanding applications will be implemented using alternative VI communications technologies, drastically curtailing the available market for DSRC at 5.9 GHz. Application developers state that plans and prototypes for DSRC solutions will have to be available in 2000 if they are to be considered as technology candidates.

U.S. DOT might mandate DSRC, but process is slow; but industry could anticipate the mandate

6. Under certain circumstances (discussed below), U.S. DOT might move toward mandating DSRC devices in new vehicles. Such rulemaking would require two or more years to complete. However, it is not unreasonable to conclude that if U.S. DOT were moving steadily toward mandatory DSRC, automotive manufacturers might begin to incorporate DSRC devices into their new vehicles in advance of a regulatory requirement to do so.

Prospect of mandate could increase DSRC appeal

7. Similarly, if there was a clear, early movement toward incorporating DSRC technology in all new vehicles, the developers of applications requiring VI communications would potentially look more favorably on DSRC as the VI communications technology alternative.

Prerequisites for U.S. DOT DSRC mandate include clear public interest and well-accepted standard. Opposition is likely in any case.

8. For U.S. DOT to consider mandating DSRC, there are (at minimum) two prerequisites.

   One is a clear public interest in the widespread deployment of DSRC. For example, an argument can be made that electronic toll collection and transparent CVO border crossings would help to relieve congestion, reduce fuel consumption, mitigate emissions, and improve safety. Similarly, DSRC-based in-vehicle warning systems could improve safety at highway-rail intersections, work sites, and other hazardous locations. The safety benefits of these applications will potentially not be realized

without broadly installed DSRC technology.

The second prerequisite is the existence of a well-accepted industry standard, consensus or de facto, for DSRC at 5.9 GHz.

Even if these prerequisites are met, it is likely that other technical interests, with alternative approaches to IV communications, would oppose such rule making.

DSRC standards needed rapidly; consortium has been proposed

9. Industry proponents of DSRC at 5.9 GHz are therefore under a significant onus to move forward at high speed toward a DSRC standard at 5.9 GHz. DSRC vendor representatives have proposed the formation of a vendor consortium to rapidly develop the relevant standard specifications and to promote the use of DSRC to the developers and deployers of applications using VI communications, notably including vehicle manufacturers.

Recommend that Consortium move ahead

10. Recommendation to DSRC technology vendors: To form a consortium to work toward the rapid development and delivery of a standard 5.9 GHz DSRC specification by late spring 2000, preferably one which encourages an open development environment that will help to enable to the broadest possible set of applications.

Recommend that U.S. DOT encourage work of Consortium

11. Recommendation to U.S. DOT: To support the work of such a consortium to prepare a suitable standard specification by late spring 2000, to the extent of:

    - Providing the services of an FCC Consultant (on such issues as band use, channelization)
    - Providing the services of a data security consultant (encryption requirements)
    - Providing the services of a standards editorial contractor (all layers)
    - Supporting common needs testing related to DSRC at 5.9 GHz:
        + Environmental – ice, snow, slush, sand, dirt, dust
        + Performance evaluation – 802.11 protocol, modulation (BPSK, QPSK, other)
        + Validate existing IEEE 1455 Layer 7 standard for use at 5.9 GHz
        + Validate new standards for Layers 1 and 2

Recommend that U.S. DOT initiate public comment on DSRC mandate

12. Recommendation to U.S. DOT: To initiate public comment, potentially leading to rulemaking on the inclusion in all new vehicles of an industry-standard DSRC transponder at 5.9 GHz. Such a process would be terminated without action if such a standard specification were not in place by mid-2000. It is suggested that U.S. DOT develop, for inclusion in the request for public comment, a draft set of criteria by which to evaluate the appropriateness of IV communications alternatives, including DSRC at 5.9 GHz. It is suggested that these criteria focus first

on the public interest related applications (e.g., safety), but also pay attention to applications of more general interest that will help to drive the market, including e-commerce and broadband applications.

Recommend that U.S. DOT encourage infrastructure deployment

13. Recommendation to U.S. DOT: At such point that a rule to mandate the inclusion of transponders appears likely, to initiate the formulation of policies and incentives to encourage state and local authorities and private sector ISPs to deploy infrastructure and develop national application standards for the deployment of interoperable toll, CVO, and warning system applications using in-vehicle DSRC at 5.9 GHz.

Stakeholders Workshop for ITS Applications at 5.9GHz

December 16-17, 1999

Holiday Inn Capitol, Washington, DC

Proceedings

Day 1

8:30-8:45 Welcome and Purpose
John Collins, President & CEO, ITS America

John Collins welcomed the group and provided some background information on current activities regarding Dedicated Short Range Communications (DSRC) in the 5.9GHz frequency band. He noted that it is an exciting time for the ITS industry and that the rapid pace of technology advancement has necessitated this workshop to bring stakeholders together to focus on the major opportunities.

He said that the U.S. DOT has requested advice from ITS America on their role in this band. This workshop is one of the major activities that ITS America will use for providing such advice. The 5.9GHz allocation provides the ITS community with great opportunities for ITS applications, international harmonization, shaping the future, and for bringing in new players and partners.

8:45-3:00 Application sessions
Rick Weiland, Facilitator

Rick Weiland thanked everyone for coming and for making themselves available on short notice. He stressed the importance of getting the right people to the table providing input to where the 5.9 GHz allocation will lead the industry. Rick described his role for the workshop to be a Facilitator, not a subject matter expert.

He reiterated the charge for the workshop – how should U.S. DOT play in this area? He also noted that DOT is potentially prepared to take on whatever role the stakeholder community feels appropriate. Another activity of the workshop is to identify whether DSRC will be overtaken by events in the industry – will competing technologies dominate the relevant applications and services? DOT is going into this without preconceived conclusions, and wants to take the role that is most useful, specifically in the standards arena.

Mr. Weiland provided an overview of the workshop agenda for the next 1-1/2 days, and the events to follow. The ultimate goal is to produce advice to DOT by May 2000., following review and approval by the ITS America Coordinating Council and Board of Directors. He further explained that if anything was left out of the agenda, it was not by design, and he is looking for the group to recommend additional stakeholders to reach out to.

Technology – Lack of a standard, ensuring interoperability, providing products at affordable prices, rapid pace of change in wireless community, migration, legacy system inertia.

Institutional – same as today, more complex because of more institutions, sunk costs.

Regulatory – band use rules, licensing.

Issue: What is the appropriate role for U.S. DOT?

Proving the market, DOT could mandate a 5.9GHz product, endorse and support the application process with the FCC, transfer of current other technology into the DSRC path (e.g. log data), endorse what is good and legitimate. [This needs some smoothing out]

If the DSRC path is through the vehicle, U.S. DOT should be working more with the automobile industry. From the OEM perspective, they need to have a standard and need to sell on huge volumes. The device needs to help sell the car for users to receive benefit. If the beacon systems are built on the highway, the OEMs will incorporate the transceiver products to communicate. There needs to be a large number of equipped vehicles on the roadways to realize significant benefits. The U.S. DOT should consider mandating tags in all vehicles.

Can DOT help build the infrastructure network? No. The state, local, and municipal governments own the roads, and U.S. DOT doesn't tell them what to do.

Can U.S. DOT mandate the services and performance parameters by a certain date, but not specify the frequency or technology? You need to have a common frequency to have interoperability.

Consider issuing mandates for both vehicle equipment and infrastructure.

Consider alternative funding sources and incentives to accelerate deployment of the infrastructure (e.g., making trust funds available, 100% federal money). Merely making the infrastructure an allowable expense under different budget categories won't get the job done.

The DSRC infrastructure is not there; however, other wireless networks are there now or are being built, which is a problem for the DSRC community. As an example, Bluetooth products are being developed ahead of the standards work. It is the application that provides the loyalty and differentiation to the customer – not the technology.

Issue: What is the appropriate role for ITS America?

Create business consortiums for developing and promoting specific applications. Given the broad and diverse range of interests, help to provide structure and organization to the continued deliberations on this issue. Provide assistance to the FCC in helping to write the NPRM – by getting industry consensus and providing input. Provide access and the opportunity of engagement to the full range of interested parties. Provide outreach and awareness to the community.

Q. What spacing needs/requirements are envisioned for the deployment and Micro and Pico cells?
A. The nominal expected separation for pico zones (short range transceivers and beacons) is 50 feet. Micro zones could be spatially overlapped by using different frequencies in each zone (Frequency Division) or different time slots in each zone (Time Division).

Q. Has vehicle-to-vehicle communication been avoided intentionally?
A. Somewhat intentional, but it is an option on the table. They haven't been able to address it yet.

Q. Will it explicitly be addressed?
A. If the users want it and provide input on requirements – they will address it.

Q. What about Canada and the shared frequency issue?
A. It needs to be addressed so as not to overlap applications.

Q. What about non-traditional concepts in the user requirements group?
A. Java applications, parking map downloads, diagnostic information exchange with service stations, large databases on buses, vehicles to update software programs are all possibilities being investigated, many of which need longer ranges and higher data rates, which 5.9 provides.

Q. Is it assumed that there will be multiple OBU (On Board Units) in vehicles?
A. Yes, but it is still subject to discussion.

Mr. Cash pointed out that at some point they will need to stop development and go with what they've got.

Financial/Toll

Ben Bates, Equiva

Equiva is a shared organization between Shell and Texaco, which operates 23,000 retail gas outlets nationwide. Mr. Bates discussed the current and future applications under consideration at Equiva, as well as the variety of technology implementations including Point Of Sale, smart card readers, monitors, and others. They are developing pump-to-vehicle communication for payments, vehicle identification and fuel management, vehicle telemetry for delivering content information to and from the vehicle. Equiva is a founding member of the IDB Forum and one of their hopes is that through this mechanism to deploy a common infrastructure in the car to retrieve diagnostic information – this capability was demonstrated at the last Consumer Electronics Show. They also have deployed a prototype RF technology for the automated pumping of gas. Equiva is looking at a variety of technologies to potentially service their applications needs, one of which is DSRC. Mr. Bates noted that other technologies than DSRC, such as Bluetooth, 802.11, Wireless LAN, Home RF and WAP, can meet their needs, and that DSRC must move swiftly to specification, prototype, and standard if it is to stay in the running.

Q. What are your concerns?
A. The number of avenues to pursue in the wireless industry. They need an ubiquitous standard for telemetry to be deployed worldwide, that is both cheap and reliable. The rapid pace of technology evolution is currently being driven by the cellular industry. Non-fuel revenue will drive their future business model.

Q. How does DSRC compare with your other technology interests/experiences?
A. Not moving quickly enough can be problematic. In other arenas, it was necessary to get in early and drive the development.

Q. Where should the leadership come from?
A. It needs to be driven by open standards. Bluetooth is an example – working towards a common goal.

Q. Does it matter if it's at 915MHz or 5.9GHz?
A. It doesn't matter, but there needs to be a common infrastructure. They are very interested in data rates. 915 technology will limit capabilities in moving forward.

Q. What does faster mean?
A. Everything shown by Equiva was first studied in a pilot phase. They are searching to roll out products in calendar year 2000 – even in small quantities. Cost targets – $10,000 per station in infrastructure, $6-8 per vehicle tag, telemetry tag $25-40 range.

Neil Schuster, IBTTA
The International Bridge Tunnel and Turnpike Association is a trade association that represents the toll industry around the world including public, private, and others with an interest in toll collection. Mr. Schuster noted that there are many different views among his membership on the DSRC issue – there is not a unified voice – some want a world standard, others want national standards, and some are still neutral. The major issue is price and cost. Many people feel the standards at 5.9GHz will take too long, even though they are critically important for the replacement of parts and equipment. Mr. Schuster said that whatever happens with 5.9GHz, there needs to be an allowance for the large swap out of batteries and tags that would be required. This migration – if there is one – needs to be transparent to the customers.

Q. What does IBTTA want?
A. National Standards are critical. A global standard is secondary.

Q. Is there a market for this product?
A. Yes – it's a technology that works – doing it cost effectively and reliably is of critical importance.

The electronic toll collection (ETC) market is growing and currently stands at about 10 million tags in circulation around the world. In some cases, plazas are experiencing 60-80% usage during prime time rush hour. Beyond ETC, we would hope follow-on technology would be able to tie into parking, transit, and drive-thru restaurants, to name a few.

Q. What is the expected time frame?
A. The toll authorities need to tell what they want.

Q. What are the technical alternatives?
A. Existing systems work and people are happy. Smart cards and the virtual toll road will eventually come. Some areas around the world already have implemented open road tolling. GPS receivers can be used as a part of a system that enables tracking a vehicle's use of toll roads and it's identification for determining payment.
Standards mean access to parts and services at a lower cost. However, it only solves one part of the problem – it can't provide interoperability. Each agency has to solve business rules and deal with the institutional issues. Bilateral and multiple agency agreements are becoming more commonplace to facilitate interoperable systems.

Q. What should be the US DOT role?
A. It needs to continue to facilitate standards in this area.

Rena Barta, E-ZPass
E-ZPass is a coalition of 15 toll agencies in 7 states. They have banded together to create an ETC system that has one tag in the vehicle that can be used in all member jurisdictions. Right now anyone can open an account with any agency and can travel to wherever the system is in place. Bank card seamlessness with payment has been achieved, but not without much work behind the scenes.

Q. What are the key elements of a regional system?
A. Business rules, compatible in-lane components, service center with reciprocity, one tag-one account

Q. Where are we today?
A. 3.2 million tags, 2.5 million accounts, 12-60% market penetration (facility dependent), 10-40% customers shared between agencies.

Q. What else could we do with the tags?
A. Currently they are being used by TRANSCOM for traffic management and incident detection (probes). Other uses could include CVO, border crossings, and parking.

Q. What are our requirements at 5.9GHz?
A. Uninterrupted service while changing to new tags is an issue, maintaining reciprocity and interoperability, reliability, non-interfering and compatibility with existing equipment, non-proprietary solutions

Q. What is the refurbishment plan (e.g., battery life issue)?
A. They intend on swapping out tags before they die. To date they haven't focused on it so a time frame has yet to be determined.

Jim Bucklar, Texas Instruments

TI has a large semiconductor and RFID business for applications such as security, labels, and automatic recognition of consumers.

Q. Why RFID?
A. Speed, flexibility, and convenience.

They also have deployed approximately 900,000 DSRC tags for communicating between fuel dispensers and vehicles, mostly with Mobil for their Speedpass application. The technology operates at two frequencies – a low data rate downlink for localization between the car and the pump, and a high frequency uplink back to the dispenser. The key is to localize the communication on vehicle for payment purposes. They can tie this application into IDB and others through having the tag operate as the gateway.

Their tags now operate in the ISM band, part 15 (unlicensed) portion of the 900MHz spectrum.

Q. How does the licensing issue affect TI's business needs?
A. As long as it can proliferate to multiple applications it's not a problem.

Q. Does the 900MHz band limit their application needs?
A. Yes.

TI has approximately 6-7 times (3.5 million) more RF keyfobs than tags in circulation. They have found in their research that people are loyal to the car tag once they buy into it. If they had to migrate to a 5.9GHz uplink, it would be a costly endeavor, but one which they would definitely do.

Q. Is there currently one keyfob for both Shell and Mobil?
A. No. they are operating at different frequencies and are not interoperable.

Security and Access

Sam Oyama, Hitachi

Japan is currently working on next generation DSRC products and systems for the coming ITS applications. They are addressing needs and issues through a recently established organization called the "ITS Info-Communications Forum". The forum has been structured to perform R&D, gather and exchange of information, promote development, and campaign for ITS. In February 1999, Japan issued a candidate list of next generation DSRC applications, and the forum was formally established in July. It includes approximately 200 organizations from both the public and private sectors such as telecommunications firms, broadcasting companies, Ministry of Post and Telecommunications, National Police Agency, Ministry of International Trade and Industry, Ministry of Transport, and the Ministry of Communications.

Currently 5.8GHz technology is being implemented in Japan for ETC only. As noted above, they have developed a whole slew of applications for the next generation. This is the main focus

of the forum. In order to implement these applications, they need more spectrum – and they have 80MHz available to them in the band.

Mr. Oyama discussed the operating structure and governance of the forum. There are several committees tackling many of the same issues as in the U.S.: roadside-vehicle and vehicle-vehicle communications, mobile communication, broadcasting systems, planning and surveying, and public relations committees, to name a few. There is an annual fee to join the forum, and it might be a model worth pursuing in the U.S. Industry membership is $1,000/year, and it is free of charge for ITS America members.

They expect to have R&D completed by March 2001.

Q. What is the forum's objective?
A. 5.8GHz standards are a primary subject. After 1-1/2 years, the research will be complete.

Q. For what services/purpose is the NPA (National Police Agency) involved?
A. Not sure, but currently infrared technology is being utilized for traffic control.

Q. Is there a relationship between ISO and the Japanese effort?
A. They are proposing one now, but one is not in place yet for the next generation systems.

Virginia Williams, Security Industry Association
Ms. Williams was called away for a last minute emergency, so Paul Najarian spoke on her behalf from remarks she had forwarded to him. Security issues need to be taken into consideration more heavily in the 5.9GHz band, as there are none that currently exist across technologies/protocols that she knows of. She concurs with Carl Kain's assessment in the White Paper he prepared as background for the workshop – each protocol currently has its own security built in. She suggested looking at the work done by NIST (National Institute of Science and Technology) with regards to rolling key security. There still needs to be some further clarification and definition of DSRC at 5.9GHz. She is willing to submit a paper for the record.

Information

Sheldon Leader, Edwards & Kelcey
DSRC is one technology that can be used as a tool for information distribution. It is expected that future transportation systems will require increased bandwidth for data transfer and for the multitude of people that will be communicating in the same time and space. These expected needs can't be accommodated with shared frequency and nor with regular radio. As noted in the previous session's discussion, some applications will require higher levels of security, which in turn requires more bandwidth. Entertainment and vehicle diagnostics are also examples of information transfer that will require more bandwidth. It is expected that there will be a certain amount of priority messaging needed which will require dedicated bandwidth.

Deployment of the infrastructure to support the DSRC needs of the future is a large task, and the question exists as to who will be responsible for it. There are many commercial interests, but these tend to be limited to their own "sphere of influence," which can lead to solutions that are

not ubiquitous. Mr. Leader suggested that the Federal and State DOTs will have to do something about this issue in order to get the services they want.

Traffic engineers and planners understand how to deploy systems; however, they rely on construction firms and maintenance organizations to build and take care of the roads. These groups typically don't think in terms of the entire roadway or taking a systems approach – they tend to divide things into portions to localize. A need exists to educate construction and maintenance organizations on ITS and the DSRC applications that are possible.
As 5.9GHz applications spring up and migrate, this will create space in the 900MHz band that will permit applications to backfill the voids. Licensing and regulatory issues need to be addressed in the 5.9GHz band to limit restrictions and promote competition in the marketplace.

Arlan Stehney, IDB Forum

Mr. Stehney opened by noting that the forum is building on the open architecture foundation that was created with the development of the ITS Databus. With this architecture now in place, there are many opportunities for the vehicle to become a pathway for digital media, control, and communications both on- and off-board. He stated that there is a large move in the industry to deliver entertainment information into the vehicle (e.g., digital music - which will replace cassettes and CDs). DSRC could be one of the technologies to deliver this information. Satellite radio could do it as well as others. Mr. Stehney noted that a gas station, which sees a car approximately every 6 days, could act as the agent for delivering the information while the driver is loading his or her vehicle with gas. There are many portable devices that also will be prime targets for this information delivery (e.g., there are currently 63 million wireless phones and 3.9 million portable computers in use around the country). There is a substantial need to integrate all of these products into the vehicle and an even larger need to address the human factors issues associated with this integration. Mr. Stehney said that IDB is the integration solution. Even though vehicle OEMs have developed vehicle buses based upon SAE standards, each manufacturer's bus is a bit different, and the IDB provides the gateway to allow communications across all of them.

Mr. Stehney further stated that the communications type, whether it's DSRC, Satellite digital radio, infrared, Bluetooth, cellular or others does not matter – there will be different applications and products that are developed and they will all have the ability to be channeled through the IDB. This will permit competition and the development of reliable and cheaper components, and OEMs and suppliers will be able to sell products to all customers, not just OEM specific.

Mr. Stehney stressed the urgency to develop products to serve the needs of the marketplace, and that we are currently in the "opportunity window for standardization." This window is fairly short, and within the next year or two the window will disappear and commercial interests will have the upper hand in the market, with or without consensus standards.

The IDB Forum is working on several versions of the next generation standards to accommodate different applications, data transfer rates, and technology migration. The movement from analog to digital is changing the landscape of opportunity. They are working through ISO and AMIC, but Mr. Stehney feels there needs to be a stronger tie to the DSRC Community. Currently there are very few DSRC stakeholders involved.

Bart Stevens, Smartmove

Mr. Stevens outlined Smartmove's interest in DSRC and that the company is engaged in developing the 3rd generation telematics platform for delivering services to and from the vehicle through wireless communications. He noted the telematics migration within the past several years – from 1st generation (no connections) to 2nd generation (some connections) to 3rd generation (upload any wireless applications – unlimited services and information to the vehicle). Smartmove is organizing the various communications types and applications, and will provide the link into the vehicle. They have developed the infrastructure that allows people to communicate with cars and serve as an aggregator of services – a new ISP with a link to the vehicle. They see two parallel paths to the market – public safety and information/services/infotainment. Safety will be the major driver, to be followed very quickly by e-commerce. In order to provide products to service these different sectors, Smartmove feels strongly a broadband solution in the spectrum is needed, and DSRC is a strong player in this realm.

Q. What is the Smartmove interface/relationship with the IDB?
A. If the IDB is the standard, they will link to them – they are not a competitor.

Q. Is Smartmove involved with Progressive Insurance on tracking with cellular phones?
A. Yes and No [This needs some elucidation]

Control

Steven Shladover, PATH

Dr. Shladover discussed the importance of the safety applications and that they must not be overlooked in whatever path DSRC takes. DSRC applications for vehicle control systems have great potential, both for vehicle-roadside and vehicle-vehicle communications. As examples, he mentioned both intersection and collision warning communication near, at, and with intersections, as well as cooperative ACC (Adaptive Cruise Control) and maneuvering, work zone warnings, and emergency vehicle and transit signal preemption. He also mentioned in-vehicle signing to notify drivers of things such as local speed limits, curves and grades, weather and road surface conditions, and other roadway geometrics. Obstacles, emergency flags, vehicle failures, traffic congestion, poor traction, safety check-in/check-out stations are also applications he mentioned that have good potential to be served by DSRC.

To provide for these services, Mr. Shladover mentioned several key issues to be addressed, such as message priority (safety and urgency), as well as the reliability and robustness of messaging. Safety critical applications may require more overhead due to the amount of handshaking and redundancy built into the systems. The hope is to build these systems to provide for future growth and needs, and to accelerate development in such a way as to create a sensor friendly environment.

He further noted that there must be national leadership provided by U.S. DOT and ITS America, and there needs to be an aggressive campaign to make people aware of the process and the benefits.

Mr. Shladover shared some State DOT concerns. Each of them has heavy investments in existing systems and infrastructure, so any movement to implement new technologies and services needs to have an appropriate migration path. Similar to federal agencies, most State DOTs are required to conduct a fair amount of research and testing to justify modifications or changes. He also suggested that this group get more direct involvement from the State DOTs to get their buy-in.

The states have great interest in wireless applications, from construction, traffic operations and maintenance, to traveler information, ETC, HOV enforcement, remote weather, traffic monitoring, freeway patrols, work zones, fleet management, and automated highway applications.

Q. Should safety-related information be integrated or separated from the IDB?
A. Not sure.

Q. Has there been any analysis conducted on the ranges needed for vehicle-vehicle communication? Is 1000ft OK?
A. 1000ft should be acceptable, most of the needs are close up. Most forward-looking sensors operate in ranges from 100-150 meters.

Mike Duoos, 3M

Mr. Duoos opened by stressing the need for radio frequency options in delivering traffic signal priority control system capabilities. He noted there are approximately 250,000 signalized intersections around the country that are candidates for offering priority control. He also mentioned there are approximately 200,000 emergency vehicles in service that could benefit from implementing this application, with the goal of providing a safe, smooth, and efficient route of travel for emergency vehicles. Seconds can mean a huge difference in saving lives and limiting both injuries and property damage.

Transit signal priority is a large market opportunity as well, in terms of on-time service. Mr. Duoos noted that this application could be implemented with minimal disruption of normal traffic and control. A few requirements are needed to offer this service: continuous communication, large communication zones (1000 meters for signal cycle times), security, and reliability (e.g., controlled band vs Part 15).

Mr. Duoos stated that if the above mentioned applications could be accommodated in the 5.9GHz band, 3M is committed to developing products.

Guy Rini, Mack Trucks

Mr. Rini explained the OEMs (especially the truck OEMs) have to accommodate many databuses (e.g., ECU, VCU, ABS, others) when designing and assembling vehicles. Mack's product development cycle typically takes 2-4 years from concept to delivery. They would like to utilize transponders to communicate off-board to trucks to provide service and fleet management functions through the diagnostic connector. Several years ago, they had planned to fold in a 915MHz tag to perform these functions, but the standard hasn't panned out, so they had

to look at alternate means to provide for their customer's needs. The market is demanding this, and the truck OEM needs to find a way with or without standards – their preference is with.

In 2000, Mack is announcing a wireless means to provide these services, which won't be using the 5.9 GHz spectrum. Although each has a different architecture and communications bus, Mack hopes that eventually there will be one standard for all vehicles – light, medium, and heavy – that supports both open and proprietary data formats. The data is now available and is being moved, but a gateway is needed to communicate on and off the vehicle. This function could be served either by software or a through a separate device.

Mack's concerns include the antennae design and installation, open field vs fixed-lane communication, and the slow pace of standards development.
Q. Should the 5.9GHz standards be U.S. DOT or industry driven?
A. U.S. DOT should have a large role in helping develop a standard for DSRC, to help in providing old functions in new ways as well as to offer new functions and a migration path for current equipment. If the industry is left to develop standards at 5.9GHz on its own, a proper solution will not come to fruition since the industry is too fragmented and includes too many biases and special interests.

Fleet session

Don Soults, NATSO - Truckstop perspective

Truckstops currently view DSRC unfavorably due to the problems that have been experienced with developing and providing interoperable products at 915MHz. Their concerns include the need to provide readers "stacked to the sky" to read all the tags, and the fact that trucks won't stop if they have to install many tags on their vehicles. To help deal with the bad PR to date, they are using the term "wireless connectivity" for the next generation applications, products, and services. Truckstops are interested in their own business world and how they can build in this capability to service their customers. Connectivity and standardization is what they are hoping for, which to date has not been successfully achieved.

In many plazas, transaction authorizations now occur at the fuel pump. This doesn't have an immediate benefit – each driver still needs a paper copy, and employees are still required at truckstops. They are hoping to institute a process for vehicles to automatically register themselves for identification, account authorization, and discounts within the truckstop campus – as well as having the capability to implement gate security, transaction authorization, and vehicle diagnostics for maintenance. There is substantial market potential for DSRC in the truckstop business.

Joe LoVecchio, Volpe Center - Transit perspective

Mr. LoVecchio noted that although he was an employee of US DOT, he had been asked to represent and speak on behalf of the transit industry. Transit properties have many interests and needs for applications that can be served quite well by DSRC technology. Such applications include access priority control, signal priority systems, scheduling changes, operational data download, engine diagnostics, ETC payments, and facility entrance control. Their requirements include both real time and periodic data, as well as stored data transfer. In terms of signal

priority systems, there are currently 23 agencies operational and 33 agencies in the planning stages. For access priority control, 30 agencies are operational and 44 are in the planning stages.

Other applications the transit properties see as providing value include natural gas fueling depots, railroad crossings, vehicle-to-vehicle fleet management (e.g., passenger transfer information). Meeting their needs is limited by the current bandwidth in the 900MHz band and thus they support development of standards at 5.9GHz.

Q. Should U.S. DOT be involved?
A. As a DOT employee I cannot endorse DOT involvement; such endorsement has to come from the community. However, my personal opinion is that DOT should be involved.

Howard Moody, American Association of Railroads – Rail perspective
For years the railroads have used one-way AEI tags for tracking shipments (backscatter technology). However, they have future needs that may require larger transmission of data and short range two-way communication. Several of the railroads now have wireless networks, but they are now looking at options for the future. The current systems in use interfere with each other and with public systems. The approach going forward they hope will provide a dedicated and licensed system that would supplement their current AEI systems (e.g., for image transfer) that will communicate to and from the locomotives at low speed, be located near yards and terminals, include railroad specific messages, permit event recorder download, and will maintain the data from the previous 24 hours, having a range of approximately 200 feet over 2 tracks. The advantages of such systems include enabling large file transactions at a low cost, leveraging the highway market to reduce costs to the rails which in comparison is a small market, non-interfering technology, and not having to compete or pay for spectrum.

AAR currently has an industry task force looking at wireless applications and technology. They support standards development to open the market and for looking at the opportunities offered with public-private partnerships.

Bob Luminati, Landstar System, Inc. – Trucking perspective
Mr. Luminati explained that Landstar runs approximately 9000 Class 8 trucks over the roads, and that he has a large concern that with each passing day the driver's cab is becoming more like the cockpit of an airplane. His drivers are not communications specialists – they are truck drivers. He noted that Landstar is in favor of U.S. DOT establishing a minimum standard for DSRC in the 5.9GHz band, and enforcing it to ensure safety and fairness. As a trucking company, Landstar's first concern is safety, and they rely on their vendors to provide them with products and services that promote safe vehicles and at a price that's cost effective. Safety is profitable. The U.S. DOT should establish the mechanisms for identifying tractors and engines, and creating unique identifiers. What is done with the rest of the vehicle information should be the industry's concern – it is related to business functions.

The industry needs one tag that does not take the operator's attention from the road. Functionality is important, for example, having technology alter vehicular operating characteristics such as changing the rate of speed is a concern and can get people killed. Mr. Luminati mentioned that DSRC has offered good advantages to the industry to date – weigh